

REMARKS

Claims 1-20 and new claim 21 and 22 are pending. New claim 22 is supported by Example 1, paragraphs [0091] to [0094] of the published application.

Rejections over Small and Sinha

Claim 1 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Small et al (U.S. Patent 7524346) in view of Sinha (U.S. Patent Publication No. 20030119319). Applicants traverse. The application which issued as U.S. Patent 7524346 was filed on January 25, 2002. The instant application claims priority to Aug. 14, 2003. Applicants declare that Small et al., which qualifies as prior art only under 35 USC 102(e), be disqualified as prior art as the inventions at the time each were made were subject to ownership by the same entity. The assignment of U.S. Patent 7524346 to EKC TECHNOLOGY, INC. dated 1/24/2002 is recorded at Reel/Frame 012540/0635, and the subsequent assignment to DUPONT AIR PRODUCTS NANOMATEIRALS L.L.C dated 08/23/2005 is recorded at Reel/Frame 016700/0301. DUPONT AIR PRODUCTS NANOMATEIRALS L.L.C. is the owner of the instant application.

A Declaration under 37 CFR 1.130 is provided herewith. Applicants believe this rejection is moot.

Further, the Examiner states that one of ordinary skill in the art would have “a reasonable expectation of predictably achieving the desired composition using the particle size of Sinha.” While this is obviously true, it is not the composition which is claimed, but rather the method of polishing with an aqueous composition comprising from about 0.0005 to about 1 moles / kilogram of periodic acid and from about 0.2% to about 6% by weight of silica abrasive having an average particle size of about 50 nm or less ... where the removal rate of the ruthenium is at least 300 Å/min. Small particle size reduces polishing rates, and one of ordinary skill in the art would not expect to achieve the inordinately high recited polishing rate with small particles.

Applicants therefore request that this rejection be withdrawn.

Rejections over Brusic and Sinha

Claims 1, 5, 7, 14, and 18 – 20 stand rejected over Brusis (U.S. Patent 6527622) in view of Sinha (U.S. Patent Publication No. 20030119319). Applicants traverse.

Claim 1 recites a method of polishing a ruthenium/dielectric surface with an aqueous composition having 0.0005 to about 1 moles / kilogram of periodic acid and from about 0.2% to

about 6% by weight of silica abrasive having an average particle size of about 50 nm or less where the removal rate of the ruthenium is at least 300 Å/min.

Brusic relates to polishing noble metals with an abrasive or pad, a liquid, and polishing additives selected from hundreds of polishing additives. The Abstract states:

The invention provides a method of polishing a substrate comprising a noble metal comprising (i) contacting the substrate with a CMP system and (ii) abrading at least a portion of the substrate to polish the substrate. The CMP systems each comprise an abrasive and/or polishing pad, a liquid carrier, and optionally one or more polishing additives. In a first embodiment, the polishing additives are selected from the group consisting of diketones, diketonates, heterocyclic nitrogen-containing compounds, heterocyclic oxygen-containing compounds, heterocyclic phosphorus-containing compounds, urea compounds, nitrogen-containing compounds that can be zwitterionic compounds, salts thereof, and combinations thereof. In a second embodiment, the polishing additive is a metal compound with two or more oxidation states and is used in conjunction with a peroxy-type oxidizer. In a third embodiment, the CMP system comprises .alpha.-alumina and fumed alumina, wherein the weight ratio of .alpha.-alumina to fumed alumina is about 0.6:1 to about 9:1.

Pending claim 1 does not recite any “a metal compound with two or more oxidation states … used in conjunction with a peroxy-type oxidizer.” Where does the Examiner provide any evidence that a slurry having “a metal compound with two or more oxidation states and a peroxy-type oxidizer” will provide a removal rate of the ruthenium is at least 300 Å/min? The Examiner suggests one of ordinary skill in the art would be inclined to modify the slurry of Bruci with particles of less than 50 nm diameter. Why? What evidence can the Examiner provide where one of ordinary skill in the art would have ANY expectation of success? Just because two references each disclose billions of potential slurries, how can any one of ordinary skill in the art by routine experimentation come up with the claimed slurry?

The Examiner continues to present a number of cumulative rejections – in each case selecting art that discloses substantially any slurry known to the industry, and then combining the reference with a reference that discloses any practicable particle size, with no teaching or direction, and then claims the claimed composition can be derived therefrom by routine experimentation. Each of the rejections herein is of that form, as were each of the rejections in the prior office action, and in the office action before that.

Brusic discloses billions of potential slurries – none of which have the composition claimed. The slurry of Brusic must contain a metal ion having multiple valences. Or fumed

alumina. Or one of the many classes of nitrogen containing compounds listed. The “slurry” of Brusic is useful for any noble metal – with no direction to polish ruthenium. “The slurry of Brusic can contain any foreseeable oxidizer – more than twenty are listed, with no direction to select periodic acid, AND with the caveat that if it is a peroxy type oxidizer, it must comprise a metal compound. The slurry of Brusic can contain any known abrasive in any foreseeable amount of abrasive -- 0.01% to 50% by weight covers any useful amount. And the Examiner combines this reference with a reference that teaches the abrasive particle can be any foreseeable size -- 10 nanometers (nm) to about 5000 nm! And from these practically INFINITE disclosures with ZERO direction the Examiner suggests the claimed invention can be come up with by routine experimentation. Does the word “routine” mean anything?

Brusic discloses polishing noble metals selected from the group consisting of platinum, iridium, rhenium, ruthenium, rhodium, palladium, silver, osmium, gold, alloys thereof, and oxides thereof. *See* claim 1. Brusic discloses in an essentially infinite class of oxidizers which may optionally be present.

The CMP systems optionally further comprise a per-type oxidizer. ... The per-type oxidizer can be any suitable per-type oxidizer. Suitable per-type oxidizers include inorganic and organic per-compounds. A per-compound (as defined by Hawley's Condensed Chemical Dictionary) is a compound containing at least one peroxy group (—O—O—) or a compound containing an element in its highest oxidation state. Examples of compounds containing at least one peroxy group include but are not limited to hydrogen peroxide and its adducts such as urea hydrogen peroxide and percarbonates, organic peroxides such as benzoyl peroxide, peracetic acid, and di-tert-butyl peroxide, monopersulfates (SO₅ 2-), dipersulfates (S₂O₈ 2-), and sodium peroxide. Examples of compounds containing an element in its highest oxidation state include but are not limited to periodic acid, periodate salts, perbromic acid, perbromate salts, perchloric acid, perchlorate salts, perboric acid, perborate salts, and permanganates. The per-type oxidizer preferably is selected from the group consisting of hydrogen peroxide, persulfate salts (e.g., ammonium persulfate), periodate salts, and permanganate salts. More preferably, the per-type oxidizer is ammonium persulfate or hydrogen peroxide.

This is substantially every known oxidizer! Brusic then discloses that any known oxidizer can be used in any practical amount:

The CMP systems can contain any suitable amount of per-type or peroxy-type oxidizer. The CMP system preferably comprises about 0.5 to about 20 wt. % per-type oxidizer with the polishing additive(s) of the first embodiment. The CMP system preferably comprises about 0.1 wt. % to

about 20 wt. % (e.g., about 1 wt. % to about 10 wt. %) peroxy-type oxidizer with the polishing additive(s) of the second embodiment. The CMP system preferably comprises about 0.5 to about 20 wt. % per-type oxidizer with the abrasive of the third embodiment.

The Examiner states on page 4 of the Office Action that Brusic discloses “about 0.2% to about 6% of silica abrasive,” citing column 13 lines 31 and 46-48. First, the examiner’s citation is wrong. Column 13 lines 31 and 46-48 relates to an example polishing platinum using a persulfate, alumina abrasive, and a “polishing additive.” Where is the correct citation. Applicants do not dispute that Brusic discloses silica along with a huge number of other abrasives.

The abrasive can be any suitable abrasive, many of which are known in the art. For example, the abrasive can be natural or synthetic and can comprise diamond (e.g., polycrystalline diamond), garnet, glass, carborundum, metal oxide, nitride, carbide, polymer, composite (e.g., polymer composite or polymer/metal oxide composite), and the like. The choice of abrasive can depend on the particular nature of the substrate being polished. The abrasive preferably comprises metal oxide, diamond, silicon carbide, silicon nitride, boron nitride, or combinations thereof. The metal oxide desirably is selected from the group consisting of alumina, silica, titania, ceria, zirconia, germania, magnesia, co-formed products thereof, and combinations thereof. More preferably, the abrasive comprises silica, alumina (e.g., alpha-alumina, fumed alumina), silicon nitride, and/or silicon carbide.

This is every known abrasive in the art? Further, Brusic discloses the amount of abrasive can be 0.01% to 50% by weight. This is any practical amount known in the art – indeed, no slurry having close to 50% abrasive is known in the industry.

The Examiner states in section 10 of the Office action that “when the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable range by routine experimentation.” Routine experimentation!!! There are BILLIONS of slurries disclosed in Brusic, with no guidance to select the disclosed invention. Routine experimentation of Brusic to obtain the claimed slurries, with no direction, would take eons. How can this possibly be characterized as routine?

Further, Brusic does not address two limitations – use of periodic acid to polishing ruthenium at a rate exceeding 300 Å/min, and the very small particle size of 50 nm or less. The Examiner in numeral 12 of the office action states Sinha discloses particles of size “(50 nm or less)”. Sinha in fact discloses

A wide variety of abrasive particles can be used either in an abrasive slurry or in a fixed abrasive article. Typically, such abrasive particles range in particle size (i.e., the largest dimension of the particle) on average from about 10 nanometers (nm) to about 5000 nm, and more often about 30 nm to about 1000 nm.

The examiner is simply picking and choosing from exhaustive undirected lists to re-create the claimed invention. How in any manner whatsoever could anything less than an infinite amount of experimentation provide the method recited in claim 1? Further, it is known in the art that small particles reduce substrate polishing rates. As stated in paragraph 0038 of the published application,

“We have surprisingly found that superior results are obtained with sub-0.05 micron minimum diameter, oblong-shaped, silica abrasive particles, particularly abrasive particle chains formed of a relatively small number of very small silica abrasive particles that adhere to one another to form a chain.”

The Examiner in number 13 of the office Action recites law supporting the Examiner’s position, quoting “when the species is clearly named, the species claim is anticipated no matter how many other species are additionally named. Ex parte A, 17 USPQ2d 1716 (Bd. Pat. App. & Inter. 1990)” As stated in the Examiner’s MPEP, in this case “The Board compared the facts to the situation in which the compound was found in the Merck Index, saying that the tenth edition of the Merck Index lists ten thousand compounds. In our view, each and every one of those compounds is 'described' as that term is used in 35 U.S.C. § 102(a), in that publication.” This same section of the MPEP discusses *In re Sivaramakrishnan*, 673 F.2d 1383, 213 USPQ 441 (CCPA 1982), stating:

The court upheld the Board's finding that a reference specifically naming cadmium laurate as an additive amongst a list of many suitable salts in polycarbonate resin anticipated the claims. The applicant had argued that cadmium laurate was only disclosed as representative of the salts and was expected to have the same properties as the other salts listed while, as shown in the application, cadmium laurate had unexpected properties. The court held that it did not matter that the salt was not disclosed as being preferred, the reference still anticipated the claims and because the claim was anticipated, the unexpected properties were immaterial.).

ALL WELL AND GOOD, IF THE REJECTION WERE INDEED AN ANTICIPATION! THE EXAMINER IS APPLYING ANTICIPATION LAW ON AN OBVIOUSNESS REJECTION. THEREFORE, THE EXAMINER IS APPLYING THE WRONG LAW. Applicants understood

after the previous interview that the issue was settled that the Examiner should make reasoned rejections only where there is a nexus and motivation to make the combination exists. The Examiner is urged to review and apply the correct law relating to obviousness, for example:

In re Jones, 958 F.2d 347, 350, 21 USPQ2d 1941, 1943 (Fed. Cir. 1992) (Federal Circuit has "decline[d] to extract from Merck [& Co. v. Biocraft Laboratories Inc., 874 F.2d 804, 10 USPQ2d 1843 (Fed. Cir. 1989)] the rule that... regardless of how broad, a disclosure of a chemical genus renders obvious any species that happens to fall within it."). See also In re Deuel, 51 F.3d 1552, 1559, 34 USPQ2d 1210, 1215 (Fed. Cir. 1995).

Reconsideration and withdrawal of the rejection of claim 1 over Brusic in view of Sinha is requested.

With respect to claim 5: Claim 5 recites the method of claim 1 ... wherein the removal selectivity of the ruthenium to the dielectric is greater than about 20:1. The Examiner cites Sinha paragraph 33, which states:

the selectivity for removal of material from a second and third row Group VIII metal-containing surface relative to materials containing other metals (e.g., BPSG or TEOS) is at least about 10:1, and more preferably, within a range of about 20:1 to about 100:1, depending on the chemistry and process conditions.

The Examiner can not combine a generic slurry of Brusic with a discloses selectivity of the slurries of Sinha WHEN SINHA DOES NOT EVEN DISCLOSE THE REQUIRED OXIDIZER! The removal rates of dielectric and of ruthenium are primarily dependent on the oxidizer used. Brusic requires a metal ion when a peroxy oxidizer is used. This will catalyze the oxidizer to form hydroxyl ions. What evidence can the Examiner present that suggests the claimed selectivity will be met? Further, claim 5 depends from claim 1, and claim 1 recites a removal rate of ruthenium of 300 A/min. Sinha discloses NO removal rates of ruthenium, no removal rates using silica abrasives, and NO removal rates AT ALL greater than 250 A/min. The Examiner is taking the extraordinarily broad disclosure of Brusic, adding in the removal rates from examples in Brusic that contain alumina abrasive and either hydrogen peroxide or persulfate and do NOT have the ingredients recited in the claim, and adding in the selectivity of Sinha who again does not recite periodic acid and whose examples are strictly limited to polishing with alumina abrasive. Such a combination is without any scientific support.

Further, the Examiner is combining selected sections without regard to the teaching of the references. Claim 5 recites high selectivity. Regarding the Example where Sinha used alumina

and either acetic acid/hydrogen peroxide or hydrogen peroxide, Sinha stated “also selectivity to oxide was poor. With only hydrogen peroxide removal rate was lower and selectivity was poorer.” There is NO reason to believe that you can obtain the selectivity of Sinha and the removal rate of Brusic, both obtained with slurries that are do not contain the ingredients recited in the claims. Reconsideration and withdrawal of the rejection of claim 5 over Brusic in view of Sinha is requested.

With respect to claims 7 and 20: Claim 7 depends from claim 1 and recites the amount of periodic acid is from about 0.01 to about 0.05 moles/kilogram of aqueous composition. Claim 20 depends from claim 1 and recites the amount of periodic acid is from about from about 0.3% to 0.7% by weight of periodic acid. The question is not whether the super broad undirected disclosures used by the Examiner include this low amount, but rather whether the combination of the references fairly teaches the claimed method. Applicants ability to obtain the recited removal rate with BOTH very small abrasive and with such a low level of oxidizer was surprising. Such results are not remotely suggested by the art. The Examiner seems to be saying that if the slurry can be obtained by combining random teachings from huge lists, then the method is obvious. This is not correct. Where is the ruthenium removal rate shown or suggested, which so low an amount of oxidizer? Reconsideration and withdrawal of the rejection of claim 7 over Bruci in view of Sinha is requested.

With respect to claim 14: Claim 14 recites the method of claim 1, wherein the substrate further comprises a hard-mask material, and wherein the polishing rate of the hardmask material is equal to or greater than the polishing rate of the ruthenium. The Examiner in numeral 16 states the dielectric can be silica or silicon nitride. The examiner is asked to provide support that any one of ordinary skill in the art would use either of silica or silicon nitride as a hardmask material. Hardmask material is not the dielectric, but the material used to form the pattern. And the slurries of this invention provide selectivity to ruthenium over that of the dielectric of near 20:1. How could one of ordinary skill in the art change the formulation which provides 20:1 selectivity of the ruthenium to the dielectric to suddenly provide selectivity to the Examiner’s version of a hardmask (a dielectric?) over ruthenium? Such a rejection has NO basis in science, and the Examiner does not appear to be addressing the claim limitations. Reconsideration and withdrawal of the rejection of claim 7 over Bruci in view of Sinha is requested.

Rejections over Dirksen and Sinha

In section 20 of the Office Action, claims 2 and 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dirksen (20020076932) in view of Sinha (20030119319). Applicants traverse.

With respect to independent claim 2: Claim 2 recites a method of polishing a substrate surface ruthenium and a layer comprising a low-K dielectric material, where the polishing agents are silica abrasive, periodic acid, and a quaternary amine, at a pH of 2.5 to 5, wherein the removal selectivity of the ruthenium to the low-K dielectric is greater than 20:1.

Dirksen teaches polishing a substrate having a metal and a dielectric, where the metal can be most any metal including ruthenium, where the polishing is done with a pad, and a polishing slurry containing most any abrasive, of which silica is an example and most any oxidizer, of which periodic acid is an example. Dirksen mentions ruthenium in paragraph [0008], though he states the preferred metal of the substrate is tungsten. Similarly, Dirksen lists various things that can be polished with his slurries, which include most every material known in the art to be polished, also including “high and low dielectric constant films.” And similarly Dirksen mentions the slurry can include any amine, including a quaternary amine, in paragraph [0020]:

Such additives include surfactants (e.g., cationic surfactants, anionic surfactants, nonionic surfactants, amphoteric surfactants, fluorinated surfactants, and mixtures thereof), polymeric stabilizers or other surface active dispersing agents (e.g., phosphoric acid, organic acids, tin oxides, and phosphonate compounds), pH buffers (e.g., potassium phosphate), and polishing accelerators such as catalysts, oxidizers, and chelating or complexing agents (e.g., metal, particularly ferric, nitrates, sulfates, halides (including fluorides, chlorides, bromides, and iodides), compounds with carboxylate, hydroxyl, sulfonic, and/or phosphonic groups, di-, tri-, multi-, and poly-carboxylic acids and salts (such as tartaric acids and tartrates, malic acid and malates, malonic acid and malonates, gluconic acid and gluconates, citric acid and citrates, phthalic acid and phthalates, pyrocatecol, pyrogallol, gallic acid and gallates, tannic acid and tannates), amine-containing compounds (such as primary, secondary, tertiary, and quaternary amines and amino acids), peroxides, periodic acid and salts, perbromic acid and salts, perchloric acid and salts, perboric acid and salts, iodic acid and salts, permanganates, potassium ferricyanide, chlorates, percarbonates, persulfates, bromates, chromates, cerium compounds, and mixtures thereof).

From these broad undirected lists in Dirksen, the Examiner apparently maintains that Dirksen discloses everything in the slurry of claim 2.

The Examiner notes Dirksen does not teach polishing where the selectivity of ruthenium to a low-k dielectric is 20 or more. In number 22 of the Office action, the Examiner says:

The reference of Dirksen is silent as to selectivity of ruthenium to the low k dielectric material. Therefore one of ordinary skill in the art would look to the related art to see the selectivity.

WHY would “one of ordinary skill in the art would look to the related art to see the selectivity?” Because it is in applicant’s claim?!? The Examiner can not just make up any reason that has no basis in the industry.

The Examiner uses Sinha at paragraph [0033] to teach selectivity of ruthenium to TEOS of greater than 20. Sinha teaches:

This is important in selectively removing material from platinum-containing or other second and third row Group VIII metal-containing layers without removing, for example, significant amounts of underlying layers, such as oxide layers and nitride layers (e.g., TEOS or BPSG layers). Preferably, the selectivity for removal of material from a second and third row Group VIII metal-containing surface relative to materials containing other metals (e.g., BPSG or TEOS) is at least about 10:1, and more preferably, within a range of about 20:1 to about 100:1, depending on the chemistry and process conditions.

However, Sinha does not teach achieving this selectivity with the composition recited in claim 2. Claim 2 recites a quaternary amine. Sinha recites an “organic amine” which is further described in paragraph [0043]:

Examples of suitable organic amines include ethylamine (EtNH_2), methylamine (MeNH_2), triethylamine (Et_3N), and trimethylamine (Me_3N).

These are the primary, secondary, and tertiary amines disclosed in Dirksen, but conspicuously absent is the quaternary amine which is recited in claim 2. That is, Sinha teaches selectivity generically but provides no motivation for selecting the recited components of the slurry from the components of Dirksen. How would one of ordinary skill in the art be fairly taught the limitations of claim 2 from the unlimited disclosure of Dirksen, which relates primarily to polishing tungsten, in combination with Sinha which discloses using organic amines (but not a quaternary amine!) in polishing of noble metals? Sinha teaches selectivity but only teaches selectivity if the slurry contains a compound not recited in claim 2.

In fact, the examples of Dirksen are made with alumina and hydrogen peroxide. Sinha ran two examples with hydrogen peroxide and alumina, one also containing acetic acid. Sinha states in paragraph [0063] that a sample was made containing:

hydrogen peroxide and 0.5 ml glacial acetic acid to 80 ml of water and 20 ml of Rodel's CMP slurry containing Al₂O₃ as the abrasive (GRANITE MSW2000 Part A). ... Polishing was carried out using a pressure of 15 pounds and a speed of 50 revolutions per minute (rpm). ... The ... calculated ... removal rate of approximately 146.5 .ANG. per minute). ... Also selectivity to oxide was poor. With only hydrogen peroxide removal rate was lower and selectivity was poorer.

That is, when using hydrogen peroxide the selectivity to platinum as poor. We can't say what Sinha might suggest about the selectivity of periodic acid slurries because Sinha does not suggest using periodic acid slurries.

The Examiner in numeral 23 states:

One of ordinary skill in the art at the time of the invention would have had a reasonable expectation of predictably achieving the desired etching selectivity based on the disclosure of Dirksen in light of the teaching of Sinha.

This conclusory statement has no scientific or logical basis. How can Applicants argue against a statement so opposite the facts? The only examples used by Dirksen were peroxide. Sinha says hydrogen peroxide provides poor selectivity. What is one of ordinary skill in the art to do? Start with a goal of the appropriate ruthenium to low-k selectivity recited by Sinha, not achieved by Sinha when using oxidizers, and then try the billions of combinations disclosed in Dirksen (excluding trying the only teaching of Sinha, that is, to use an organic amine, and using oxidizers where Sinha suggested results are poor) until a combination is obtained which reaches the desired selectivity? When the only Sinha slurries containing oxidizer both tested showed "poor selectivity?" There is no direction to select the slurries claimed from cited prior art.

Additionally, the Examiner no provides ZERO motivation to combine these references.

With respect to motivation, the Examiner in the previous Office action stated:

At the time of the invention, it would have been *prima facie* obvious to one of ordinary skill in the art to modify the method of DIRKSEN to include the method of SINHA because it would provide a method for the removing of 2nd and 3rd row Group VII metal layers without removing significant amounts of underlying layers such as oxide and nitride layers (dielectric layers) (Page 4 Paragraph [0033]).

The Examiner was directed by the SPE during the previous interview to reconsider the stated motivation quoted above. In reply, the current office action IS ENTIRELY SILENT ABOUT ANY MOTIVATION TO CONBINE THESE REFERENCES!

Additionally, the Examiner has not provided evidence that the low hydroxyl silica required by Dirksen is capable of achieving the recited polishing selectivity of ruthenium to a low-k substrate.

Applicants request reconsideration of this rejection of claim 2 over Dirksen in view of Sinha.

With respect to claim 16: Claim 16 recites the method of claim 2 wherein the pH of the aqueous composition is between about 3 and about 4. Dirksen in paragraph [0018] teaches a low pH, but only to maintain the low hydroxyl content of the silica.

[0018] The metal oxide abrasive composition preferably has a pH of about 6 or less, e.g., about 5-6. More preferably, the composition has a pH of about 5 or less, e.g., about 4-5. Such a relatively lower pH will not function to reduce the total surface hydroxyl group density of the metal oxide abrasive, but rather provides for maintenance of a reduced total surface hydroxyl group density with respect to the metal oxide abrasive for a significant period of time, e.g., during storage of the metal oxide abrasive composition before use in a polishing or planarizing process.

Teaching that the abrasive should be stored long-term at pH 4-5 does not teach that the polishing composition must have a pH of 3-4 as recited in claim 16. THIS WAS ARGUED PREVIOUSLY. DID THE EXAMINER CONSIDER APPLICANT'S ARGUMENTS?

Applicants request reconsideration of this rejection of claim 16.

Rejections over Dirksen, Moeggenborg, Wang, and Sinha

In section 25 of the Office action claims 3, 6, and 10 stand rejected over Dirksen (20020076932) in view of Moeggenborg (20030060135) and Wang (U.S. Patent 6316365) and in further view of Sinha (20030119319). Applicants note that this rejection is similar to the rejection of claims 3, 6, and 10 as being unpatentable over Dirksen in view of Moeggenborg and Wang (U.S. Patent No. 6316365), in further view of Ina (U.S. Patent No. 6355075) that were argued over last Office action. Applicants traverse.

With respect to independent claim 3: Claim 3 recites a method of polishing a substrate surface comprising ruthenium, at least one feature comprising tantalum oxide, and a dielectric material, with an aqueous composition comprising from about 0.1% to about 3% by weight periodic acid, from about 0.2% to about 6% by weight of silica abrasive having an average particle size of about 50 nm or less, wherein the composition comprises less than about 0.5% of

sources of chloride ions; and wherein the polishing rate of tantalum oxide is between about 0.8 and 1.7 times the polishing rate of ruthenium.

The Examiner states in number 26 of the Office action that Dirksen teaches polishing a substrate “comprising ruthenium, a low dielectric film and a high dielectric film (tantalum oxide).” It is absolutely unknown why the examiner put “(tantalum oxide)” in this sentence. In fact Dirksen states:

[0008] The substrate comprises a metal, metal oxide, metal composite, or mixture thereof. The substrate can comprise, consist essentially of, or consist of any suitable metal. Suitable metals include, for example, copper, aluminum, titanium, tungsten, gold, platinum, iridium, ruthenium, and combinations (e.g., alloys or mixtures) thereof. Preferably, the metal of the substrate is tungsten. The substrate also can comprise, consist essentially of, or consist of any suitable metal oxide. Suitable metal oxides include, for example, alumina, silica, titania, ceria, zirconia, germania, magnesia, and combinations thereof. Preferably, the metal oxide of the substrate is silica. In addition, the substrate can comprise, consist essentially of, or consist of any suitable metal composite. Suitable metal composites include, for example, metal nitrides (e.g., titanium nitride and tungsten nitride), metal carbides (e.g., silicon carbide and tungsten carbide), and nickel-phosphorus. Substrates that consist essentially of, or consist entirely of, silicon are not suitable substrates for the method of the present invention. The present invention is particularly well-suited for the planarizing or polishing of memory or rigid disks, metals (e.g., noble metals), ILD layers, integrated circuits, semiconductors, micro-electro-mechanical systems, ferroelectrics, magnetic heads, polymeric films, and low and high dielectric constant films.

Applicants do not see Dirksen polishes “a substrate surface having at least one feature thereon comprising ruthenium and at least one feature comprising tantalum oxide, and a dielectric material.” In fact, despite mentioning nearly every substrate known in integrated circuits and in memory disks, Dirksen does not mention tantalum oxide anywhere. Is the examiner implying that a high dielectric film of Dirksen is the same as tantalum oxide? Where is the evidence?

The Examiner notes in number 27 of the Office action that Dirksen does not teach a layer of tantalum oxide, the amount of periodic acid recited, the amount and recited size (an average particle size of about 50 nm or less) of the silica abrasive, the chloride limitation, nor that the polishing rate of the tantalum oxide is between about 0.8 and 1.7 times the polishing rate of ruthenium.

The Examiner also states in number 27 “(removal rat ratio of ruthenium: tantalum oxide is 0.58-1.25 calculated based on polishing rate of 300 A/min, disclosed on page 25 of

Specification)," but the truth and the significance of this is strongly contested. Is the Examiner is using a ruthenium removal rate of claim 1, or the ruthenium removal rate of an example, to modify the recited limitation of independent claim 2? Where in the MPEP is this said to be permissible? If not, WHAT DOES THIS MEAN?

Finally, in number 27, the Examiner states something that Applicants completely agree with.

Therefore one of ordinary skill in the art at the time of the invention would have been motivated to look to the related art for suitable _____

We have previously argued that there is no motivation for anyone of ordinary skill in the art to select the slurry claimed, nor to select the properties recited in the claim. We interviewed this case, and the SPE asked the Examiner to reconsider the motivation and propriety of the combinations. The unfinished sentence suggests the examiner has no motivation.

The Examiner in number 28 of the Office action then apparently uses Moeggenborg to teach the recited amount of periodic acid, saying Moeggenberg teaches periodic acid (true, along with most other known oxidizers), at a concentration of in "amounts between "0.001% to 5%" (the examiner is adding an extra zero), somehow gleaning this amount from the paragraphs [0016] and [0017] of Moeggenborg. Moeggenborg at paragraph [0016] also teaches most oxidizers known in CMP, and at paragraph [0017] teaches a concentration of oxidizer encompassing substantially all known concentrations used in CMP. Moeggenborg also teaches an oxidizer must be combined with a cerium salt, and all examples use hydrogen peroxide. The presence of the cerium salt would be expected to play havoc with the selectivity of tantalum oxide to ruthenium, but the Examiner ignores this since the Examine's slurry is simply a hypothetical slurry having properties from different slurries having different compositions from different prior art sources.

The Examiner in number 29 of the Office action apparently uses Sinha to disclose particles 50 nm or less. Sinha in fact discloses:

A wide variety of abrasive particles can be used either in an abrasive slurry or in a fixed abrasive article. Typically, such abrasive particles range in particle size (i.e., the largest dimension of the particle) on average from about 10 nanometers (nm) to about 5000 nm, and more often about 30 nm to about 1000 nm.

The examiner is simply picking less than 50 nm from Sinha's disclosure of all usable sizes. The examiner also states in number 29 of the Office action that "one of ordinary skill in the art at the

time of the invention would have had a reasonable expectation of predictably achieving the desired composition using the particle size of Sinha.” The composition is not claimed. This is a method claim. Who desired the composition? The Examiner is inventing a slurry from disparate prior art in clear and obvious hindsight reconstruction of the claim.

The Examiner then apparently uses Wang as stated in the Office Action at number 30:

WANG discloses a method of chemical mechanical polishing comprising a substrate with a tantalum removal ratio of the tantalum containing component in relation to the metal layer can be greater than 1 and the removal rate ratio can be less than 1 (Col. 4 lines 60-67).

Applicants are not entirely sure why this art is pertinent. First, Wang uses a totally different slurry and does not disclose polishing EITHER of the two compounds recited in claim 3.

Wang discloses polishing a metal and “tantalum” (metal) or a “tantalum containing component” where the polishing rate of one to another is greater than 1 or less than 1. the tantalum containing component is not taught to be tantalum oxide. That “teaching” regarding selectivity is an absolute truism of polishing ANY dissimilar materials! The only time this “disclosure” is not met is if two dissimilar materials are polished at EXACTLY the same rate, which simply means the polisher is not measuring with sufficient accuracy. So Wang discloses the basic principle of selectivity, where selectivity is greater than 1 or is less than 1. This is NOT teaching “the polishing rate of tantalum oxide is between about 0.8 and 1.7 times the polishing rate of ruthenium.”

The examiner then says

It further discloses that the metal can be ruthenium (Col. 4 lines 32- 36).

Although WANG does not explicitly disclose applicant's polishing rate, the removal rate ratio of WANG overlaps that of applicant.

FIRST, WHERE IN CLAIM 3 DOES THE EXAMINER SEE A REMOVAL RATE? THE EXAMINER IS MAKING UP CLAIM LIMITATIONS AND THEN CLAIMING THE ART MAKES THE LIMITATIONS OBVIOUS! WE STRONGLY OBJECT TO THESE REPEATED REJECTIONS THAT HAVE NO BASIS IN SCIENCE NOR LAW.

More to the point, Wang is teaching TWO separate slurries – a “conductive metal-selective” slurry and a “tantalum-selective” slurry. A “tantalum-selective” slurry polishes tantalum more than the conductive metal, and a “conductive metal-selective” slurry polishes metal more than the tantalum. See Wang, column 3, lines 43-67. So Wang does not teach the claimed selectivity – unless two slurries are used.

Claim 3 further recites polishing a "feature comprising tantalum oxide." Wang only teaches polishing tantalum or tantalum nitride. Wang states:

The metal vias and contacts generally employ an adhesion layer (hereinafter referred to as a "barrier film"), such as a titanium (Ti), titanium nitride (TiN), tantalum (Ta), or tantalum nitride (TaN) barrier film, to adhere the metal layer to the SiO₂ substrate.

and

The term "tantalum" refers to tantalum itself, as well as tantalum-containing compounds. Thus, the tantalum can be in the form of, for example, tantalum metal or tantalum nitride.

Can the Examiner PLEASE point out where the art teaches the claim limitations, instead of merely repeating the same limitations. I do not see tantalum oxide. Examiner, WHERE IS IT? Tantalum and tantalum nitride have properties different than tantalum oxide and of course do not polish the same as tantalum oxide. Wang does not teach polishing tantalum oxide.

The Examiner further states in paragraph 31 that:

Although WANG does not explicitly disclose applicant's polishing rate, the removal rate ratio of WANG overlaps that of applicant. "In the case where the claimed ranges 'overlap or lie inside ranges disclosed by the prior art' a prima facie case of obviousness exists. *In re Wertheim*, 541 F.2d 257, 191 USPQ 90 (CCPA 1976); *In re Woodruff*, 919 F.2d 1575, 16 USPQ2d 1934 (Fed.Cir. 1990)." MPEP 2144.05(1)

Claim 3 recites a ratio of polishing rates, not any absolute polishing rate. WANG does not explicitly disclose applicant's polishing rate? Where does the Examiner see a polishing rate? The Examiner does not say where in Wang he gets the rates. We are absolutely clueless from what disclosure the Examiner is manufacturing the data, but we presume it is from the Examples of Wang (all of which use persulfate as an oxidizer – which is absolutely contrary to the claim). Is the Examiner basing our selectivity range for independent claim 3 on the ruthenium rate recited in independent claim 1. This is impermissible. Surely the Examiner is not saying our claim of recited selectivity of tantalum oxide to ruthenium is obvious because in another claim we recite a ruthenium removal rate of 300 A/min and because Wang in some examples using persulfate as an oxidizer has a tantalum rate of a few hundred A/min, and since tantalum contains one element in tantalum oxide the claimed method is obvious. Such a rejection is totally without logic.

Applicants recite a selectivity ratio. Because in claim 1 we recite the minimum polishing rate is 300 A/min does not mean claim 3 reciting a selectivity is obvious over any other slurry which teaches polishing tantalum at 300 A/min (with no indication of the polishing rate of ruthenium, and said slurry not containing the oxidizer recited in claim 3). What is the selectivity ratio if the oxidizer is not a persulfate as in Wang but is periodic acid as recited in claim 3? Would the slurry of Wang even polish ruthenium? Or is the Examiner merely suggesting that the polishing rate of tantalum can be a several hundred A/min with some slurries described in Wang, and the ruthenium rate can be a several hundred A/min using other slurries described in Moeggenborg, so a claim having a recited selectivity ratio (as in claim 3) is per se obvious? Applicants are not claiming a TANTALUM POLISHING RATE, nor even a TANTALUM OXIDE POLISHING RATE.

The Examiner in section 32 suggests law that a particular parameter must be recognized as a result-effective variable, and then it can be optimized. We are absolutely clueless what the Examiner considers a result-effective variable. One of ordinary skill in the art would be able to come up with the selectivity by combining the references. This is without any scientific basis. Why, because various slurries (none of which are like those shown in the claims) polish various materials at different rates?

Applicants again request reconsideration of this rejection.

Rejections over Dirksen, Sinha, and Brusic

In section 39 of the Office Action Claim 4 is rejected over Dirksen (20020076932) in view of Sinha and Brusic ('662). Applicants traverse.

With respect to claim 4: Claim 4 recites a method of polishing a substrate surface having a noble metal with an aqueous periodic acid solution having 0.0005 to about 1 moles 1 kilogram of periodic acid with the pH adjusted to between about 3 and about 7 with a quaternary amine, and adding from about 0.2% to about 6% % by weight of silica abrasive having an average particle size of about 50 nm or less to the pH-adjusted aqueous composition to form a polishing slurry.

The Examiner in paragraph 39 of the Office action implies Dirksen teaches polishing ruthenium (paragraph 0008) with an aqueous solution (paragraph 0020), adjusting the pH to between 3-7 with a quaternary amine (paragraphs 0018, 0019) and silica abrasives (paragraph 0009).

In reality Dirksen teaches polishing any metal.

(0008) The substrate comprises a metal, metal oxide, metal composite, or mixture thereof. The substrate can comprise, consist essentially of, or consist of any suitable metal. Suitable metals include, for example, copper, aluminum, titanium, tungsten, gold, platinum, iridium, ruthenium, and combinations (e.g., alloys or mixtures) thereof. Preferably, the metal of the substrate is tungsten. The substrate also can comprise, consist essentially of, or consist of any suitable metal oxide. Suitable metal oxides include, for example, alumina, silica, titania, ceria, zirconia, germania, magnesia, and combinations thereof. Preferably, the metal oxide of the substrate is silica. In addition, the substrate can comprise, consist essentially of, or consist of any suitable metal composite. Suitable metal composites include, for example, metal nitrides (e.g., titanium nitride and tungsten nitride), metal carbides (e.g., silicon carbide and tungsten carbide), and nickel-phosphorus.

And Dirksen teaches most any abrasive:

[0009] The metal oxide abrasive can be any suitable metal oxide that can function as an abrasive. Suitable metal oxides include alumina, silica, titania, ceria, zirconia, germania, magnesia, and combinations thereof. Preferably, the metal oxide abrasive is silica. More preferably, the metal oxide abrasive is fumed silica.

But actually, Dirksen does not use normal silica but rather low hydroxyl silica – see paragraph 0010. In paragraph 0018 Dirksen teaches

[0018] The metal oxide abrasive composition preferably has a pH of about 6 or less, e.g., about 5-6. More preferably, the composition has a pH of about 5 or less, e.g., about 4-5. Such a relatively lower pH will not function to reduce the total surface hydroxyl group density of the metal oxide abrasive, but rather provides for maintenance of a reduced total surface hydroxyl group density with respect to the metal oxide abrasive for a significant period of time, e.g., during storage of the metal oxide abrasive composition before use in a polishing or planarizing process. The metal oxide abrasive also can be chemically treated to inhibit hydrolyzation during storage of the metal oxide abrasive composition.

That is, the low hydroxyl silica is stored at pH less than 6, as otherwise the low hydroxyl functionality will be lost during long term storage. In paragraph 0019 Dirksen teaches that the pH of the silica can be adjusted with any acid or base.

[0019] The pH of the metal oxide abrasive composition can be adjusted, if necessary, in any suitable manner, e.g., by adding a pH adjuster to the composition. Suitable pH adjusters include, for example, bases such as potassium hydroxide, ammonium hydroxide, sodium carbonate, and mixtures thereof, as well as acids such as mineral acids (e.g., nitric acid and

sulfuric acid) and organic acids (e.g., acetic acid, citric acid, malonic acid, succinic acid, tartaric acid, and oxalic acid).

Finally Dirksen teaches the composition can contain periodic acid in paragraph 0020:

[0020] The metal oxide abrasive composition optionally can further comprise one or more other additives. Such additives include surfactants (e.g., cationic surfactants, anionic surfactants, nonionic surfactants, amphoteric surfactants, fluorinated surfactants, and mixtures thereof), polymeric stabilizers or other surface active dispersing agents (e.g., phosphoric acid, organic acids, tin oxides, and phosphonate compounds), pH buffers (e.g., potassium phosphate), and polishing accelerators such as catalysts, oxidizers, and chelating or complexing agents (e.g., metal, particularly ferric, nitrates, sulfates, halides (including fluorides, chlorides, bromides, and iodides), compounds with carboxylate, hydroxyl, sulfonic, and/or phosphonic groups, di-, tri-, multi-, and poly-carboxylic acids and salts (such as tartaric acids and tartrates, malic acid and malates, malonic acid and malonates, gluconic acid and gluconates, citric acid and citrates, phthalic acid and phthalates, pyrocatecol, pyrogallol, gallic acid and gallates, tannic acid and tannates), amine-containing compounds (such as primary, secondary, tertiary, and quaternary amines and amino acids), peroxides, periodic acid and salts, perbromic acid and salts, perchloric acid and salts, perboric acid and salts, iodic acid and salts, permanganates, potassium ferricyanide, chlorates, percarbonates, persulfates, bromates, chromates, cerium compounds, and mixtures thereof).

The Examiner uses Brusic to provide really broad compositional ranges for the oxidizer and the solids, noting that while Brusic discloses really huge ranges and not the relatively narrow range claimed in claim 4.

The Examiner in paragraph 42 uses Sinha to show polishing a surface comprising ruthenium and a dielectric material, and also to provide very broad abrasive size ranges which encompass the claimed range. The Examiner states that when a range encompasses a claimed range a *prima facie* case of obviousness exists.

Again, the amount of periodic acid and the particle size are critical. The criticality was described in the specification. See paragraph [0038] of the published specification, which states

[0038]We have surprisingly found that superior results are obtained with sub-0.05 micron minimum diameter, oblong-shaped, silica abrasive particles ...

The arguments about selecting various unrelated aspects of hugely broad disclosures with no direction has already been argued in sections above, and the same arguments are applicable here.

But all that aside, the claims teach adjusting the pH of an aqueous slurry of periodic acid with a quaternary amine, and then adding the silica abrasive to the pH –adjusted solution.

PLEASE read paragraph [0101] of the published application.

[0101] We earlier explained that the compositions of polishing slurries are given by the weight percent of ingredients added, but that components can interact one with another. Surprisingly, we found that even if the compositions of two slurries were identical, the method of preparing the slurry can have a substantial effect. Method A starts with an aqueous periodic acid solution, then adds silica, and then adjusts the pH with TMAH. Therefore, the silica is exposed to the low pH of the aqueous periodic acid solution in Method A. Method B starts with an aqueous periodic acid solution, then adjusts the pH with TMAH, and then adds silica. Surprising, the performance of slurries made according to methods A and B differ significantly, as shown in Example 2 to 4 below, which compares formulations made with method A versus method B for formulations having 0.5% periodic acid at pH 4.

THIS IS WHAT WE CLAIMED. The Examiner rejected this before, we pointed out to the Examiner that the Examiner was ignoring an important claim limitation, and the Examiner rejects the claim again, continuing to ignore the claim limitation which is SIMPLY NOT TAUGHT IN THE ART. The fact that someone stores silica at low pH to preserve low hydroxyl functionality and says the pH can be adjusted is not pertinent. Can the Examiner PLEASE show us explicitly where in the cited prior art it teaches or suggests adding silica to aqueous periodic acid only after the pH of the aqueous periodic acid has been adjusted with a quaternary amine. In other words, show us where in the art THE CLAIMED INVENTION is taught. Applicants have spent hours combing through these exhaustive references without finding any description of the claimed invention.

Reconsideration of the rejection of claim 4 is requested.

Rejections over Brusic ('662) in view of Sinha as applied to claim 1, and further in view of Jacquinot (US 6043159)

In paragraph 44 of the Office action claims 8 and 11-13 are rejected over over Brusic ('662) in view of Sinha as applied to claim 1, and further in view of Jacquinot (US 6043159).

All arguments relating to claim 1 over Brusic in view of Sinha are incorporated here, as Jacquinot (US 6043159) does not remedy the many deficiencies of the rejection of claim 1.

With respect to claim 8: Claim 8 recites the method of claim 1, wherein the silica abrasive is substantially spherical silica particles with a particle size of about 4 nanometers to about 25 nanometers.

The Examiner in paragraph 45 of the office action again quotes Sihha paragraph 0036, suggesting (?) this art teaches the range of from about 4 nanometers to about 25 nanometers. Sinha in fact discloses

A wide variety of abrasive particles can be used either in an abrasive slurry or in a fixed abrasive article. Typically, such abrasive particles range in particle size (i.e., the largest dimension of the particle) on average from about 10 nanometers (nm) to about 5000 nm, and more often about 30 nm to about 1000 nm.

As stated in the instant specification at paragraph [0041]:

[0041] ABRASIVE-SILICA: For certain substrates, particularly those containing ruthenium, silica abrasives are desired. Particle size of the silica can range from 3 microns to 3 nanometers. As is known in the art, fine control of particle size is needed to minimize defects. The silica abrasives for very fine features are by necessity also very fine. We have found that particles below 0.05 microns, preferably below 0.2 microns, are particularly useful. It is desirable in some embodiments to use substantially pure, i.e., ultra-high purity silica with less than 0.3 ppm metals, substantially spherical silica particles with a particle size of 4 nanometers (0.004 microns) to 25 nanometers is useful.

The Examiner seems intent on ignoring Applicant's claimed surprising and unexpected results as described in the specification. Generally, in the art, polishing noble metals with small particles results in extremely low polishing rates and in smearing. Sinha in no way directs one to use small particle silica to polish ruthenium – ALL of Sinha's examples use alumina abrasive of greater than 100 nanometers to polish platinum. Applicants surprisingly found that smaller diameter abrasives coupled with low concentrations of oxidizer are useful for ruthenium

As applicants obtained unexpected results, and as the prior art did not remotely direct one toward the claimed method, Applicants request reconsideration of the rejection of claim 8.

With respect to claim 11: Claim 11 recites the method of claim 1, wherein at least 50% of the weight of the silica should be in a chain-like structure with a length-to-width ratio of at least 4.

The Examiner in paragraph 50 states:

Jacquinot discloses a method of chemical mechanical polishing a substrate where an aqueous solution of colloidal particles of pyrogenic silica, fumed

silica (silica with a 100% chain-like structure) with a length to width ratio of at least 4 (col 1 lines 53-56, assume structure length of 500 nm, width 50 nm, disclosed ratio of 10. One of ordinary skill in the art at the time of the invention would have had a reasonable expectation of predictably achieving the desired etching conditions using the silica particles of Jacquinot.

First, Applicants can not follow the Examiner's statement or reasoning.. Jacquinot relates to polishing silica, as shown by his Abstract

Process for the chemical mechanical polishing of a layer of isolating material based on silicon or a silicon derivative, in which abrasion of the layer of isolating material is carried out by rubbing said layer using a fabric which brings into play an abrasive containing an acid aqueous solution of colloidal silica containing individualized colloidal silica particles, not linked together by siloxane bonds, and water as the suspension medium and new abrasives based on such suspensions.

In the cited paragraph, Jacquinot states:

Generally primary particles of spherical silica of 5 to 50 nanometers are obtained which form particle aggregates of a length generally comprised between 50 and 500 nanometers.

Claim 11 (unlike claim 12) does not provide for aggregates but rather requires a chain-structure, where the structure has an average particle size of 50 nm or less. If the Examiner's argument is based on 500 nm aggregates, the limitations of claim 11 are not taught. A chain like structure is not an aggregate – see claim 13.

This art does not teach the limitations of the claim. This exact same argument was made in the previous response. How can the Examiner send sequential rejections that provide other combinations without addressing the key deficiencies of the cited art?!

And again, motivation to combine these references is without reasonable basis. Claim 1 recites polishing ruthenium, and requires a minimum ruthenium polishing rate. Jacquinot's particles are used to polish a silica dielectrics. Why does the Examiner think its obvious to use an abrasive designed for polishing silica in a slurry used for ruthenium? We asked this question before. The Examiner did not bother answering. Why would one of ordinary skill in the art use the aggregates Jacquinot uses at concentrations of 5 to 50% to polish silica for polishing ruthenium. Where is the nexus? Any? Is it just because these aggregates exist it would be obvious to use them?

Applicants request reconsideration of the rejection of claim 11.

With respect to claim 12: Claim 12 recites the method of claim 1, wherein at least 50% of the weight of the silica is in aggregates with an aggregate diameter of about 0.03 to 0.05 microns before polishing.

In sections 51 and 52 of the Office action the Examiner states (with spellings corrected):

With respect to claim 12, the modified teachings of Brusic do not explicitly disclose where least 50% of the weight of the silica is in aggregates with an aggregate diameter of about 0.03 to 0.05 microns before polishing. Therefore one of ordinary skill in the art would have been motivated to look to the related art to look for suitable particle for etching.

Why would someone be motivated to look at other particles? To solve what problem? There are only two groups of people who thought to do this – the inventors to obtain better polishing of ruthenium and the Examiner to hind-sight re-create the claimed invention. The Examiner can not continue to say it is obvious to combine disparate unrelated parts of prior art with no motivation other than the disparate parts exist.

Applicants request reconsideration of the rejection of claim 12.

With respect to claim 13: Claim 13 recites the method of claim 1, wherein wherein the silica abrasive comprises both silica particles in a chain-like structure with a length-to-width ratio of at least 4, and also silica particles in aggregates with an aggregate diameter of about 0.03 to 0.05 microns, and wherein before polishing at least 70% of the weight of the silica is contained in the chain-like structures and the aggregates.

The Examiner presented the same contorted reasoning here as was presented in paragraph 50 above. The claims require silica aggregates with an aggregate diameter of about 0.03 to 0.05 microns. The Examiner cites a structure having a length of 0.05 microns and a length of 0.5 microns as the basis for his rejection. And totally ignores the requirement of a chain like structure. As the cited art does not disclose the recitations of the claim, Applicants request reconsideration of the rejection of claim 13.

Rejections over Dirksen (20020076392) in view of Sinha and further in view of Brusic ('622)

The Examiner in section 57 of the Office action rejected claim 9 over Dirksen (20020076932) in view of Sinha (20030119319) and further in view of Brusic ('622).

The arguments relating to claim 2 over the cited references is incorporated by reference, as Brusic does not remedy the deficiencies of Dirksen in view of Sinha.

Claim 9 recites the method of claim 2, wherein the silica abrasive is present in an amount between about 0.2% to about 1% by weight and the periodic acid is present in an amount from about 0.01 to about 0.05 moles/kilogram of fluid.

The Examiner states in paragraph that the modified teaching of Dirksen (as applied to claim 2) is silent as to the concentrations of silica and periodic acid, and therefore one of ordinary skill in the art would have been motivated to look to related art to obtain concentrations to polish a structure having ruthenium and an abrasive.

The Examiner in section 60 of the Office action completely misrepresents the disclosure of Brusic, and then says:

While Brusic does not disclose Applicant's exact concentrations, generally, differences in concentration or temperature will not support patentability of subject matter encompassed by the prior art unless there is evidence indicating such concentration or temperature is critical.

Such evidence is supplied by the specification at paragraph [0016] and [0090].

[0016]... In embodiments useful for Ruthenium-containing substrates, the amount of periodic acid is preferably from about 0.01 to about 0.05 moles/kilogram, alternatively between about 0.1% to 0.9% by weight, for example between about 0.3% to about 0.7%, by weight of the fluid composition. A particularly preferred amount for very fine polishing of very small structures having ruthenium and having a tantalum oxide barrier layer has from 0.4% to 0.6%, i.e., about 0.5% of periodic acid. Such amount has been surprisingly found to provide adequate polishing rates of these very fine structures such as 0.1 to 0.8 nanometer gates and the barrier layers without damaging, corroding, or polishing the other material features in the gate, especially when used with silica abrasive material.

[0090] ... The polishing composition should not substantially polish the high K material, i.e., PETEOS or TEOS material, on the substrate, such that the ruthenium/high K selectivity is greater than 2, preferably greater than 10. Compositions of the current invention that meet these criteria comprises between 0.1 and 0.9% by weight, for example between about 0.3% to about 0.7%, of periodic acid by weight of the fluid composition. A particularly preferred amount for very fine polishing of very small structures having ruthenium has from 0.4% to 0.6%, i.e., about 0.5% of periodic acid. ... Such amount has been surprisingly found to provide adequate polishing rates of Ru metal and other components such as tantalum oxide without, corroding or polishing the high-K material such as TEOS features, especially when used with silica abrasive material ...

The Examiner is invited to see the examples disclosed in paragraphs [0091] to [0093] of the published specification, which show higher ruthenium removal rates at 0.5% silica than at 3% silica. In contrast, Brusic “teaches” the amount of abrasive can be 0.01% to 50% by weight.

Typically, about 0.01 wt. % or more (e.g., about 0.05 wt. % or more) abrasive will be present in the polishing composition. More typically, about 0.1 wt. % or more abrasive will be present in the polishing composition. The amount of abrasive in the polishing composition typically will not exceed about 50 wt. %, more typically will not exceed about 20 wt. %. Preferably, the amount of abrasive in the polishing composition is about 0.5 wt. % to about 10 wt. %.

Applicants surprisingly found that low concentrations of both silica and periodic acid combined in a single slurry provided fast polishing of fine ruthenium structures without attacking the dielectric nor a tantalum oxide barrier layer. Such teaching is not suggested in the art. The Examiner suggests one would

Applicants request reconsideration of the rejection of claim 9.

Rejections over Dirksen (20020076932) in view of Sinha and further in view of Wang ('365)

The Examiner in section 61 of the Office action rejected claim 15 over Dirksen (20020076932) in view of Sinha (20030119319) and further in view of Wang (US 6316365). This is remarkably similar to the previous rejection where Claim 15 is rejected over Dirksen (20020076932) in further view of INA et al (U.S. Patent No. 6,355,075) in view of Sinha (20030119319) and further in view of Wang (US 6316365).

The arguments relating to claim 2 over the cited references is incorporated by reference, as Wang does not remedy the deficiencies of Dirksen in view of Sinha.

Claim 15 recites the method of claim 2, wherein the substrate comprises at least one of tantalum oxide or titanium oxide, and wherein the polishing rate of the tantalum oxide and/or titanium oxide is between about 0.9 and 1.3 times the polishing rate of ruthenium. Recall claim 2 recited the removal selectivity of the ruthenium to the low-K dielectric is greater than 20:1. Applicants traverse.

The Examiner relies on Wang to disclose polishing conductive metals such as copper, but also mentioning ruthenium, and tantalum compounds with another metal where the selectivity is greater than 1 or less than 1. That is, Wang discloses that the polishing rate of the tantalum compound is greater than, or is less than, the polishing rate of the metal. Further, the slurries of

Wang, which do not contain the recited periodic acid oxidizer but rather polishes with a persulfate, and the Wang slurry which provide these rates are at pH 6.4 and up as opposed to the claimed pH range of 2.5 to 5. But the rate of tantalum removal brackets the 300 Å/min which is no where in the claims but which Examiner insists on using nevertheless.

There is NO disclosure of polishing tantalum oxide in Wang. Wand states:

The term "tantalum" refers to tantalum itself, as well as tantalum-containing compounds. Thus, the tantalum can be in the form of, for example, tantalum metal or tantalum nitride.

We are unclear on how the Examiner is basing the rejection. The Examiner seems to be hypothesizing that if we are held to the ruthenium rate recited in claim 1 (but not in the existing claim 2), then the tungsten rates of Wang bracket the 300 Å/minute removal rate for ruthenium, so if Wang used periodic acid rather than his persulfate and used pH 2.5 to 5 instead of his 6.4 plus, and if the rates of tantalum compound removal were unchanged when Wang made such hypothesized changes, and if the rate of tantalum compound (tantalum or tantalum nitride) were the same as the removal rate of tantalum oxide which Wang does not mention, then Wang makes the selectivity range obvious. And then the Examiner suggests it would be obvious to modify Dirksen with Wang (related to polishing copper and tantalum). How? By adding persulfate?

The claim recite two SIMULTANEOUS polishing selectivities. The Examiner seems to be rejecting the claims on a truism (polishing selectivity is greater than 1 or less than 1) of a compound not in the claim, a collection of polishing rates of different slurries from different sources (most of which contain none or at most one of the claimed slurry components) and comparing those rates to the minimum rate recited in an unrelated independent claim. The Examiner's twisty reasoning and unrelated picking of various characteristics of slurries (while ignoring the compounds which provide those characteristics of the various slurries) and Examiner's insistence that we be held to some polishing rate which is not in the claim merely show Examiner could not develop a reasonable *prima facie* case.

The Examiner's statement about a "result-effective variable" in section 65 of the Office action is total fabrication. What is a result-effective variable? The type of oxidizer, the amount of oxidizer, the type of abrasive, the amount of abrasive, the particle size of the abrasive, the components being polished, and the presence or absence of any of the hundreds of additives disclosed in the prior art? The Wang reference requires a persulfate oxidizer? How can the Examiner state that a similar polishing result can be expected with periodic acid? The

Examiner's reasoning is incredible, and can ONLY be based on Applicants' disclosure. Because none of the recited prior art references teach the combination that Applicants found.

Reconsideration of the rejection of claim 15 is requested.

Rejections over Brusic in view of Sinha and further in view of Shemo ('365)

The Examiner in section 66 of the Office action rejected claim 17 over Brusic in view of Sinha (20030119319) and further in view of Shemo. The arguments relating to claim 1 over the cited references is incorporated by reference, as Shemo does not remedy the deficiencies of Brusic in view of Sinha.

Claim 17 recites the method of claim 1, wherein the aqueous composition consists essentially of water, periodic acid, one or more quaternary amines, and the silica abrasive, and wherein the solution has a pH of about 2 to about 5.

The Examiner merely suggests the rejection of claim 1 applies, and states in Section 69 and 70 of the Office action that Shemo discloses a quaternary amine, and that it would be obvious to include it to reduce chattering.

Brusic requires something in his slurry, though admittedly most slurry components known in the art are taught to be optionally present in any practicable amount, a fact used exhaustively by the Examiner in these many rejections. But Brusic requires:

diketones, diketonates, urea compounds, heterocyclic nitrogen-containing compounds, heterocyclic oxygen-containing compounds, heterocyclic phosphorus-containing compounds, nitrogen-containing compounds that can be zwitterionic compounds

or

at least one polishing additive selected from metal compounds with two or more oxidation states, wherein the metal compound is soluble in the liquid carrier,

or

alpha.-alumina and fumed alumina.

The presence of any of these takes the scope of the disclosure out of the range of the claims. Sinha requires a "complexing agent selected from the group of a cyclic diene, an organic amine, and combinations thereof."

How can these references be combined to provide a slurry consisting essentially of water, periodic acid, one or more quaternary amines, and the silica abrasive?

Reconsideration of this rejection of claim 17 is requested.

WITH RESPECT TO CLAIMS 18-20

The Examiner indicates claims 18-20 are rejected but does not indicate why they are rejected. An explanation of the rejection, or preferably an allowance, is requested.

Conclusion

An allowance is earnestly requested.

A check for \$1110 and a request for extension of time separately accompany this submission.

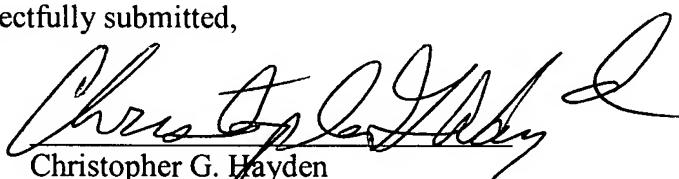
A check for \$104, believed to be due for the added claims, accompanies this submission.

Except for issue fees payable under 37 C.F.R. 1.18, the Commissioner is hereby authorized by this paper to charge any additional fees during the entire pendency of this application including fees due under 37 C.F.R. §§ 1.16 and 1.17 which may be required, including any required extension of time fees, or to credit any overpayment to Hayden Stone PLLC Deposit Account No. 50-3975.

Respectfully submitted,

Date December 23, 2010

By:



Christopher G. Hayden

Reg. No. 44,750

HAYDEN STONE PLLC

2212 Mt Vernon Ave

Alexandria VA 22301